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National Advisory Committee for Aeronautics

Research Abstracts

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CURRENT NACA REPORTS

NACA Rept. 1008

A SMALL-DEFLECTION THEORY FOR CURVED SANDWICH PLATES. Manuel Stein and J. Mayers. 1951. ii, 6p. diagrs. (NACA Rept. 1008. Formerly NACA TN 2017)

A small-deflection theory that takes into account deformations due to transverse shear is presented for the elastic-behavior analysis of orthotropic plates of constant cylindrical curvature, with consideration of buckling included. The theory is applicable primarily to sandwich construction.

NACA Rept. 1019

RELATION BETWEEN INFLAMMABLES AND IGNITION SOURCES IN AIRCRAFT ENVIRONMENTS. Wilfred E. Scull. 1951. iii, 38p. diagrs., 6 tabs. (NACA Rept. 1019. Formerly NACA TN 2227)

Data, which are applicable to the problem of aircraft fire hazards, were obtained from a literature survey and analyzed and discussed. Data pertaining to the ignition characteristics of inflammables ignited under various experimental conditions by heated surfaces, electric sparks and arcs and flames or hot gases are presented. Possible remedial measures, indicated by the survey to be capable of reducing aircraft fire hazards, are discussed.

NACA Rept. 1020

MEASUREMENTS OF AVERAGE HEAT-TRANSFER AND FRICTION COEFFICIENTS FOR SUBSONIC FLOW OF AIR IN SMOOTH TUBES AT HIGH SURFACE AND FLUID TEMPERATURES. Leroy V. Humble, Warren H. Lowdermilk and Leland G. Desmon. 1951. ii, 15p. diagrs. (NACA Rept. 1020. Formerly RM E7L31; RM E8L03; RM E50E23; RM E50H23)

An investigation of forced-convection heat transfer and associated pressure drops was conducted with air flowing through smooth tubes for an over-all range of surface temperature from 535° to 3050° R, inlet-air temperature from 535° to 1500° R, Reynolds number up to 500,000, exit Mach number up to 1, heat flux up to 150,000 Btu per hour per square foot, length-diameter ratio from 30 to 120, and three entrance configurations. Most of the data are for heat addition to the air; a few results are included for cooling of the air. The over-all range of surface-to-air temperature ratio was from 0.46 to 3.5.

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NACA TN 2612

STRESS PROBLEMS IN PRESSURIZED CABINS. W. Flügge, Stanford University. February 1952. 91p. diagrs. (NACA TN 2612)

The report presents information on the stress problems in the analysis of pressurized cabins of high-altitude aircraft not met with in other fields of stress analysis relating to aircraft. The material may be roughly divided into shell problems and plate problems, the former being concerned with the curved walls of the cabin or pressure vessel and the latter being concerned with small rectangular panels of its walls, framed by stiffeners, but not necessarily plane.

NACA TN 2613

DETERMINATION OF INDICIAL LIFT AND MOMENT OF A TWO-DIMENSIONAL PITCHING AIRFOIL AT SUBSONIC MACH NUMBERS FROM OSCILLATORY COEFFICIENTS WITH NUMERICAL CALCULATIONS FOR A MACH NUMBER OF 0.7. Bernard Mazelsky. February 1952. 30p. diagrs., tab. (NACA TN 2613)

The indicial lift and moment functions for a pitching airfoil are calculated for a Mach number of 0.7 from the available flutter coefficients for an oscillating airfoil. Comparison of the indicial lift functions at a Mach number of 0 and 0.7 indicates that the growth of lift to the steady state is less rapid for compressible flow than for incompressible flow.

NACA TN 2614

ANALYTICAL INVESTIGATION ON SOME THREE-DIMENSIONAL FLOW PROBLEMS IN TURBOMACHINES. Frank E. Marble and Irving Michelson, California Institute of Technology. March 1952. 109p. diagrs., 2 tabs. (NACA TN 2614)

The flow of an incompressible inviscid fluid through a turbomachine with blade rows consisting of an infinite number of similar infinitely thin blades has been investigated theoretically in order to examine and describe the three-dimensional flow phenomena and to illustrate the methods of calculation developed.

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NACA TN 2623

COMPARISON OF SUPERSONIC MINIMUM-DRAG AIRFOILS DETERMINED BY LINEAR AND NONLINEAR THEORY. E. B. Klunker and Keith C. Harder. February 1952. 19p. diagrs. (NACA TN 2623)

Supersonic profiles of minimum pressure drag for a given thickness ratio and for a given area have been determined with the use of a nonlinear pressure relation and compared with minimum-drag profiles found by linearized theory. The results show that linearized theory is adequate for determining the profile shape, though not the drag, for Mach numbers from 2 to 10 for optimum airfoils with a finite trailing-edge thickness.

NACA TN 2624

FLAME SPEEDS OF METHANE-AIR, PROPANE-AIR, AND ETHYLENE-AIR MIXUTRES AT LOW INITIAL TEMPERATURES. Gordon L. Dugger and Sheldon Heimel. February 1952. 25p. diagrs., tab. (NACA TN 2624)

Flame speeds were determined for methane-air, propane-air, and ethylene-air mixtures at -73° C and for methane-air mixtures at -132° C. The data extend the curves of maximum flame speed against initial mixture temperature previously established for the range from room temperature to 344° C. Both a thermal and diffusion theory predicted the effect of low initial temperatures within approximately 20 percent, as was found previously for high initial temperatures. The low-temperature data also extended the linear correlations between maximum flame speed and calculated equilibrium active-radical concentrations, which were established by the reported high-temperature data. Flame speed was determined from the total area of the outside edge of the shadow of a nozzle flame.

NACA TN 2625

SUMMARY OF ACCELERATION AND AIRSPEED DATA FROM COMMERCIAL TRANSPORT AIRPLANES DURING THE PERIOD FROM 1933 TO 1945. Walter G. Walker and Roy Steiner. February 1952. 30p. diagrs., 5 tabs. (NACA TN 2625)

Normal acceleration and airspeed data collected in transport airplanes from 1933 to 1945 are summarized and analyzed with respect to gusts and gust loads. The accelerations experienced in most operations equaled or exceeded the limit-gust-load-factor increment, on the average, twice (once positive and once negative) in 10^7 flight miles. The gusts experienced in most operations exceeded 33 feet per second, on the average, twice (once positive and once negative) in 10^7 flight miles. The loads experienced for several operations varied appreciably from average conditions. A predominating factor causing the variations in the load experience was the differences in the gust experience, with operating speeds in rough air being a secondary contributing or moderating factor.

NACA TN 2632

CORROSION OF MAGNESIUM ALLOY ZK60A IN MARINE ATMOSPHERE AND TIDEWATER. Fred M. Reinhart, National Bureau of Standards. February 1952. 10p. photos., 4 tabs. (NACA TN 2632)

The corrosion resistance of unprotected magnesium-zinc-zirconium alloy ZK60A was determined in a marine atmosphere and in tidewater. The unprotected alloy was so rapidly attacked in tidewater that it would be of no practical value in applications subject to wetting by sea water. In the marine atmosphere, the rate of corrosion was much less and the alloy should give good service if adequately protected.

NACA TN 2638

STUDY OF INADVERTENT SPEED INCREASES IN TRANSPORT OPERATION. Henry A. Pearson. March 1952. 29p. diagrs., tab. (NACA TN 2638)

Some factors relating to the speed and Mach number margins required in operation of transport airplanes are discussed for the purpose of indicating how these margins should vary with the airplane qualities. Most of the cases investigated show that on a percentage basis smaller margins should be required of the faster airplane than the slower airplane. Equations are suggested which allow these margins to be estimated.

NACA TN 2645

EFFECTS OF WING LIFT AND WEIGHT ON LANDING-GEAR LOADS. Dean C. Lindquist. March 1952. 42p. diagrs., photo., tab. (NACA TN 2645)

The effects of wing lift and weight on maximum landing gear loads were investigated by drop testing a small landing gear with an oleo shock strut in the Langley impact basin. Lift forces were mechanically applied to the dropping mass to produce wing lift factors between 0 and 2.0. Dropping weight ranged between 1000 and 2500 pounds. The results show the relationship between lift force, weight, and landing-gear loads for a range of vertical velocities between 0 and 12 feet per second.

NACA TN 2647

IMPLICATION OF THE TRANSPORT EQUATION FOR THE SEMIEMPIRICAL TREATMENT OF SHIELDS. Philip Schwed. March 1952. 31p. (NACA TN 2647)

The semiempirical method of dealing with shields by treating them as composed of layers is revised and extended by taking the angular distribution of the radiation into account and by making use of the trans-

port equation to obtain expansions suitable for special cases. Such expansions are given for the case where multiple scattering with angular deviation is of relatively little import and for the contrary case where this latter process dominates. A method for obtaining the parameters for layers of finite thickness from data on very thin layers is presented. The expansion used for the case where multiple scattering dominates is illustrated by consideration of a thick nonabsorbing neutron shield of high atomic weight. The physical significance of the expansion coefficients introduced is determined.

NACA TN 2648

EXPERIMENTAL INVESTIGATION OF TRANSITION OF A MODEL HELICOPTER ROTOR FROM HOVERING TO VERTICAL AUTOROTATION. S. E. Slaymaker, Robert R. Lynn and Robin B. Gray, Princeton University. March 1952. 29p. diagrs., photos. (NACA TN 2648)

An experimental investigation was made of the variation of average induced flow around a model helicopter during transition from hovering flight to steady autorotative vertical descent. Test data were obtained from simulated power failures under many different conditions. Results are summarized for variation in disk loading, blade angles, and pitch-change rate and "effective induced velocities" calculated for the various conditions are presented. Comparisons of theoretical and experimental data indicate that conditions peculiar to vertical descent in the transition range cause variations in performance not predicted by the theoretical analysis.

NACA TN 2649

EFFECT OF MACH NUMBER ON THE FLOW AND APPLICATION OF COMPRESSIBILITY CORRECTIONS IN A TWO-DIMENSIONAL SUBSONIC-TRANSONIC COMPRESSOR CASCADE HAVING VARIED POROUS-WALL SUCTION AT THE BLADE TIPS. William B. Briggs. March 1952. 43p. diagrs., photos. (NACA TN 2649)

A 65-(12)10 compressor blade cascade was evaluated at design geometry for Mach numbers from 0.12 to 0.89 with the boundary layer controlled through upstream slots and porous walls. The suction control was specified by a two-dimensionality criterion. The data show the effect of Mach number on turning angle, blade wake, blade profile pressure distribution, and static-pressure rise. The influence of suction on these parameters and secondary losses is illustrated. A system for correlating the experimental static-pressure rise with the theoretical is presented. Prandtl-Glauert and Kármán-Tsien compressibility correction predictions are compared with the data. A new method utilizing the vector-mean velocity and the contraction coefficient is presented.

NACA TN 2650

RADIOAUTOGRAPHIC METHOD FOR EXAMINING DISTRIBUTION OF PARTICLES IN A CYCLOTRON BEAM. M. L. Pool and S. Fultz, Ohio State University Research Foundation. March 1952. 20p. diagrs., photos., 5 tabs. (NACA TN 2650)

The relative distribution of particles emitted from activated metal foil has been obtained by the use of radioautographs of the foil, and hence the time-averaged distribution of particles in the cyclotron beam which causes activation of the foil can also be obtained. This has been established for Kodak Super Pan Press B film provided the maximum photographic density of the radioautograph is kept below 1.1. The method has been confirmed by direct comparison of density values and count rates and has also been verified for higher energy components of the β-rays emitted from the foils.

NACA TN 2651

SUPERSONIC CONICAL FLOW. Stephen H. Maslen, Brown University. March 1952. 32p. diagrs., tab. (NACA TN 2651)

A numerical method is described for the solution of the nonlinear equations for supersonic conical flow. The procedure is a combination of the method of characteristics and the relaxation process. A method for calculating the position of the shock is inherent in the analysis. The method presented is applicable to any conical flow and a solution for the flow about a triangular wing with supersonic leading edges is included as an illustration.

NACA TN 2652

APPLICATION OF A CHANNEL DESIGN METHOD TO HIGH-SOLIDITY CASCADES AND TESTS OF AN IMPULSE CASCADE WITH 90° OF TURNING. John D. Stanitz and Leonard J. Sheldrake. March 1952. 65p. diagrs., photos., 2 tabs. (NACA TN 2652)

A technique is developed for the application of a channel design method to the design of high-solidity cascades with prescribed velocity distributions as a function of arc length along the blade-element profile. The technique applies to both incompressible and subsonic linearized compressible (ratio of specific heats equal to -1.0), nonviscous, irrotational, fluid motion. An impulse cascade with 90° turning was designed for incompressible flow and was tested at the design angle of attack over a range of downstream Mach number from 0.2 to choke flow. To achieve good efficiency, the cascade was designed for prescribed velocities with maximum allowable blade loading according to limitations imposed by considerations of boundary-layer separation.

NACA TN 2653

A THERMODYNAMIC STUDY OF THE TURBINE-PROPELLER ENGINE. Benjamin Pinkel and Irving M. Karp. March 1952. 90p. diagrs. (NACA TN 2653)

Equations and charts are presented for computing performance parameters of a turbine-propeller engine for any given set of operating conditions and component efficiencies. In order to illustrate some of the turbine-propeller system performance characteristics, the total thrust horsepower per unit mass rate of air flow and the specific fuel consumption are presented for a wide range of flight engine design operating conditions and given design component efficiencies. The performance of a turbine-propeller engine containing a matched set of components is presented for a range of engine operating conditions. The influence of the characteristics of the individual components of off-design-point performance is shown. The flexibility of operation of two turbine-propeller engines is discussed; one engine has a divided turbine system in which the first turbine drives only the compressor and the second turbine independently drives the propeller, and the other engine has a connected turbine system which drives both the compressor and the propeller.

NACA TN 2655

CRITICAL STUDY OF INTEGRAL METHODS IN COMPRESSIBLE LAMINAR BOUNDARY LAYERS. Paul A. Libby, Morris Morduchow and Martin Bloom, Polytechnic Institute of Brooklyn. March 1952. 40p. diagrs., 3 tabs. (NACA TN 2655)

A number of the most promising integral methods for solving approximately the compressible-laminar-boundary-layer equations are investigated in order to determine a convenient and accurate method of calculating boundary-layer characteristics. The chief methods considered are the one-parameter Kármán-Pohlhausen method with three different assumptions for the velocity profiles and the two-parameter method with two different assumptions for the velocity profiles. Comparison of the results is made with those of known exact solutions for skin-friction and heat-transfer coefficients, velocity profiles, velocity derivatives, and especially laminar-boundary-layer stability. From this comparison, it is found that Kármán-Pohlhausen method with the sixth-degree polynomial as the velocity profile is the most suitable for many practical purposes.

NACA TN 2658

LAMINAR BOUNDARY LAYER OVER FLAT PLATE IN A FLOW HAVING CIRCULAR STREAMLINES. Artur Mager and Arthur G. Hansen. March 1952. 28p. diagrs., tab. (NACA TN 2658)

The laminar-boundary-layer development over a semi-infinite flat plate placed in a flow with concentric circular streamlines was investigated with the limitation of small total turning of the main-stream flow. The shape of the velocity profiles in the direction of the main-stream flow and perpendicular to it was analytically determined for an incompressible flow and a compressible flow with Prandtl number equal to 1. The boundary-layer thickness was shown to be proportional to the square root of the distance from the leading edge of the plate when measured along the streamline of the main-stream flow. The deflection of the boundary-layer flow at the plate surface from the direction of a circular streamline in the main flow was shown to vary directly with the turning. With increase in the Mach number of the main-stream flow, both the boundary-layer thickness and the deflection increased.

NACA TN 2664

EXPERIMENTAL INVESTIGATION OF THE TURBULENT-BOUNDARY-LAYER TEMPERATURE-RECOVERY FACTOR ON BODIES OF REVOLUTION AT MACH NUMBERS FROM 2.0 TO 3.8. Howard A. Stine and Richard Scherrer. March 1952. 20p. diagrs. (NACA TN 2664)

A turbulent-boundary-layer temperature recovery factor of 0.885 ± 0.011 was measured on both a 10° cone and a 40° cone cylinder at Mach numbers from 2 to 3.8 and Reynolds numbers based on surface kinematic viscosity from 4×10^5 to 4×10^6. Comparisons are made with available theories and experiments.

NACA TN 2666

TWO-DIMENSIONAL SUBSONIC FLOW PAST ELLIPTIC CYLINDER BY THE VARIATIONAL METHOD. G. V. R. Rao, New York University. March 1952. 39p. diagrs., 3 tabs. (NACA TN 2666)

A method of solution is presented for compressible fluid flow past an elliptic cylinder by means of the variational method. The solution is obtained as a function of thickness ratio and free-stream Mach number. Numerical examples are carried out for several thickness ratios and Mach numbers and the results are compared with those obtained by other methods. It is seen that the variational method yields good results for flow past a thick body at a low Mach number as well as for flow past a thin body at a high Mach number.

NACA RM 51G11

EFFECTIVE MODULUS IN PLASTIC BUCKLING OF HIGH-STRENGTH ALUMINUM-ALLOY SHEET. James A. Miller and Pearl V. Jacobs, National Bureau of Standards. September 1951. 15p. diagrs., 2 tabs. (NACA RM 51G11)

Results of compressive tests on duplicate longitudinal specimens from sheets of 75S-T6 and R301-T aluminum alloys in three thicknesses are presented as graphs of tangent modulus E_t, secant modulus E_s, and $\sqrt{\frac{1}{4} + \frac{3}{4}\frac{E_t}{E_s}}$ plotted against stress on a dimensionless basis. These functions may be used to obtain values of the plasticity coefficients referred to in "A Unified Theory of Plastic Buckling of Columns and Plates" by Elbridge Z. Stowell (NACA Rep. 898). In Stowell's theory the critical stress computed for the elastic case is multiplied by the appropriate plasticity coefficient to give the critical stress for the plastic case.

NACA RM E51G14

EXPERIMENTAL INVESTIGATION OF AN 0.8 HUB-TIP RADIUS-RATIO, NONTWISTED-ROTOR-BLADE TURBINE. David H. Silvern and William R. Slivka. December 1951. 18p. diagrs. (NACA RM E51G14)

An experimental investigation of an 0.8 hub-tip radius ratio, nontwisted-rotor-blade turbine designed for a stagnation-pressure ratio of 2.5 and an equivalent mean blade speed of 643 feet per second was made in a cold-air turbine with (a) nontwisted stator blades, and (b) twisted stator blades designed to maintain zero rotor-inlet incidence angles. Turbine efficiencies of the order of 0.85 at the design point were obtained with a nontwisted-rotor-blade turbine with a hub-tip radius ratio of 0.80. The turbine with the twisted stator blades gave higher efficiencies at the design point (of the order of 1.5 percentage points) than the turbine with the nontwisted stator blades.

NACA TM 1264

CALCULATION OF THE LATERAL-DYNAMIC STABILITY OF AIRCRAFT. (Raschet Bokovoi Dinamicheskoi Ustoichivosti Samolets). A. Raikh. February 1952. 82p. diagrs., 4 tabs. (NACA TM 1264. Trans. from Central Aero-Hydrodynamical Institute, Transactions, No. 453, 1939).

Graphs and formulas are given with the aid of which all the aerodynamic coefficients required for computing the lateral dynamic stability can be determined. A number of numerical examples are given for obtaining the stability derivatives and solving the characteristic-stability equation. Approximate formulas are derived with the aid of which rapid preliminary computations may be made and the stability coefficients corrected for certain modifications of the airplane. A derivation of the lateral-dynamic-stability equations is included.

UNPUBLISHED PAPERS

N-12716*

BOUNDARY LAYER IN COMPRESSIBLE GAS. (Pogranichnyi sloi v szhimaemon gaze). A. Dorodnitsyn. 65p. diagrs., 2 tabs. (Trans. from Prikladnaya Matematika i Mekhanika, v. 6, no. 6, 1942, p. 449-486).

Considers a laminar boundary layer of a compressible gas with absence of heat exchange between the body and the flowing gas. With certain assumptions various methods of boundary-layer theory for noncompressible fluid may be applied to the gas. For the laminar layer, the integral equation analogous to the Kármán equation is given and for its solution the Pohlhausen method is generalized and applied. The cases of plates and bodies of revolution are considered. The generalization of the Blasius-Howarth method is examined. The paper also considers a turbulent boundary layer in a compressible gas. The basic assumptions and expressions for the dynamic values are given.

DECLASSIFIED NACA REPORTS

NACA RM E8F01

PHOTOGRAPHIC STUDY OF COMBUSTION IN A ROCKET ENGINE. I - VARIATION IN COMBUSTION OF LIQUID OXYGEN AND GASOLINE WITH SEVEN METHODS OF PROPELLANT INJECTION. Donald R. Bellman and Jack C. Humphrey. August 26, 1948. 51p. photos., diagrs., tab. (NACA RM E8F01) (Declassified from Restricted, 1/3/52)

Motion pictures up to 3000 frames per second were taken of the combustion of liquid oxygen and gasoline in a 100-pound thrust rocket engine. The effect of seven methods of propellant injection on the uniformity of combustion was investigated. The flame front was generally found to extend to the injector faces and all the injection systems showed considerable nonuniformity of combustion. Pressure vibration records indicated combustion vibrations that corresponded to resonant-chamber frequencies.

NACA RM E50F19

INTERNAL-FILM-COOLING EXPERIMENTS IN 4-INCH DUCT WITH GAS TEMPERATURES TO 2000° F. George R. Kinney and John L. Sloop. September 21, 1950. 34p. diagrs., tab. (NACA RM E50F19) (Declassified from Restricted, 1/3/52)

An investigation of film cooling was conducted in a 4-inch-diameter duct at gas temperatures from 600° to 2000° F and Reynolds numbers from 400,000 to 1,400,000. The coolants were water and ethylene glycol at flows of 1 to 6 percent of the gas flow. During vaporization of the liquid film, coolants kept the duct wall below the boiling temperature of the liquid; little additional duct cooling was obtained from coolant vapor alone. Data were generalized over part of the coolant-flow range by use of heat-transfer relations in a form that facilitates prediction of coolant flow required to film-cool a duct for a desired length when temperature and flow of the hot gas are known.

NACA RM E51C13

INVESTIGATION OF ANNULAR LIQUID FLOW WITH COCURRENT AIR FLOW IN HORIZONTAL TUBES. George R. Kinney and Andrew E. Abramson. May 25, 1951. 33p. diagrs., photos., 2 tabs. (NACA RM E51C13) (Declassified from Restricted, 1/3/52)

Visual observations and flow analyses were made of annular liquid flow with cocurrent air flow in horizontal tubes. Experiments were conducted with air temperatures of 80°, 475°, and 800° F, air-stream Reynolds numbers from 410,000 to 2,900,000, and liquid flows from 0.3 to 21 percent of air flows. Annular liquid films were approximately 0.0005 to 0.005 inch thick. Film surface changed from relatively smooth with the liquid annulus in the region where viscous forces are appreciable to disturbed

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where turbulent forces are predominant. Change in cooling effectiveness of liquid films in film-cooling experiments was related to film-surface change; surface condition could be predicted approximately knowing liquid flow and viscosity.

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